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U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
A. C. TRUE, DIRECTOR.

ANNUAL REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION, 1904.

BY

JARED G. SMITH,
Special Agent in Charge.

[Reprint from Annual Report of the Office of Experiment Stations for the year ended June 30, 1904.]

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ANNUAL REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION, 1904.

By Jared G. Smith, *Special Agent in Charge.*

The work of the Hawaii Agricultural Experiment Station has been a continuation of the various lines of investigation described in previous reports. As stated in the preliminary report, the funds of the station have been largely invested in acquiring an equipment of buildings, tools, apparatus, and books, without which it is difficult to undertake investigations and experiments. Much of the time of the special agent has been devoted to superintending building, clearing, and other operations of a similar character, and the station now possesses a modest laboratory for chemical and entomological investigations and a good reference library well developed along the lines of tropical agriculture, horticulture, chemistry, and entomology, which are housed in comfortable buildings.

BUILDING OPERATIONS.

A new insectary, 12 feet 6 inches by 25 feet, with glass sides and roof, concrete floor, benches, breeding cages, and water fixtures, was built adjacent to the entomological laboratory, and two small cottages for laborers and an addition to one of the stables were also built. The Territorial legislature appropriated $3,000 toward the construction of a fire-proof library, office, and laboratory building (Pl. XIV, fig. 1), and $1,500 for a chemist's residence. These sums were wholly inadequate for their purposes, and to prevent losing them entirely an arrangement was made by which the station supplied certain features. In addition to the residence for the chemist, the station built a four-room cottage for the use of the entomologist. These and the other buildings have been painted, some grading has been done, and additional roads constructed. The water supply of the station proved inadequate for laboratory and other purposes last year, and in order to overcome this difficulty and provide a supply for irrigation purposes a drainage shed was erected on the higher portion of the station grounds, where there is an abundance of rain, and two 10,000-gallon tanks were constructed to provide a better and more permanent water supply. These operations, which were believed to be essential to the station, have made a serious inroad on its income, and have to a degree caused a temporary cutting down of some of the investigations planned for the year, but it is believed that with the beginning of the fiscal year 1906 the station will be in a position to do as good work and as much of it, considering the number of scientists employed, as at many of the older institutions. A telephone line has been erected connecting the various buildings with each other and with the city system. Four acres of land surrounding the main office has been placed in a first-class condition and will be used for plat experiments. About 15 additional acres of pasture land have been fenced and cleared of guava and lantana. Considerable additions have been made to the library through purchases and exchanges, so that the station now possesses the best working library in subjects relating to agriculture in the Territory.

FUNDS.

As stated in the annual report for 1903, the Territorial legislature appropriated $5,000 per year for two years for assistance to the station and $1,000 as a part of the salary of the station chemist. At a special session of the legislature the appropriation for the station was cut down to $2,730, and the amount set aside for the chemist's salary was cut out entirely. This action was necessary for reasons of economy. The falling off of the revenue of the islands had been so marked that there were not sufficient funds to supply the needs of the local government, and the station was made to feel the necessity for retrenchment. It is unfortunate that this local support has been lost. The station is maintained for the benefit of the agriculture of the islands, and even a small appropriation from Territorial funds would serve to bring the station and the interests and industries of the islands into closer relationship.

COOPERATION WITH TERRITORIAL AUTHORITIES.

The funds appropriated by the Territory are apportioned to various purposes by the board of commissioners of agriculture and forestry, acting on recommendations made by the special agent in charge of the station. About one-half of the funds now available has been set aside for carrying on tobacco experiments on the island of Hawaii. A tract of land has been leased for a number of years and experiments are being made with Sumatra and Habana tobaccos grown in the open and under shade. A preliminary report of this investigation is given elsewhere.

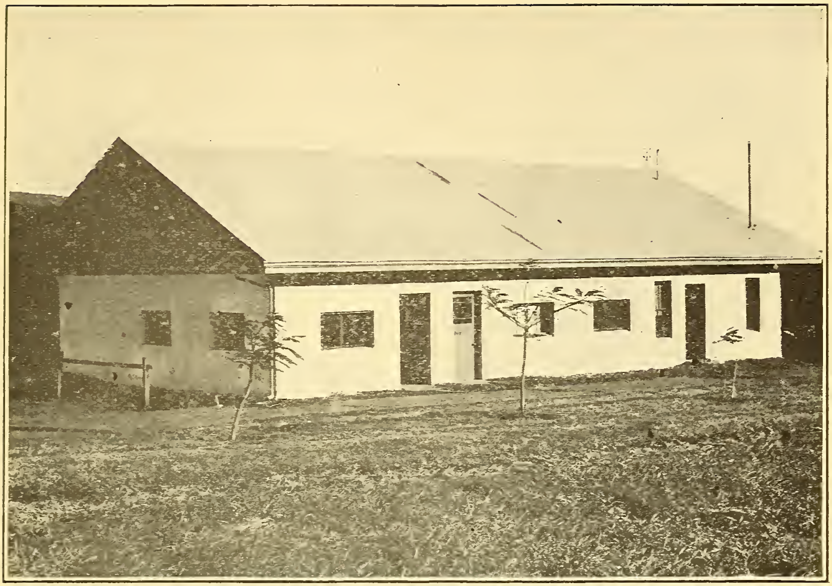

FIG. 1.—NEW OFFICE AND LABORATORY BUILDING AT HAWAII STATION.

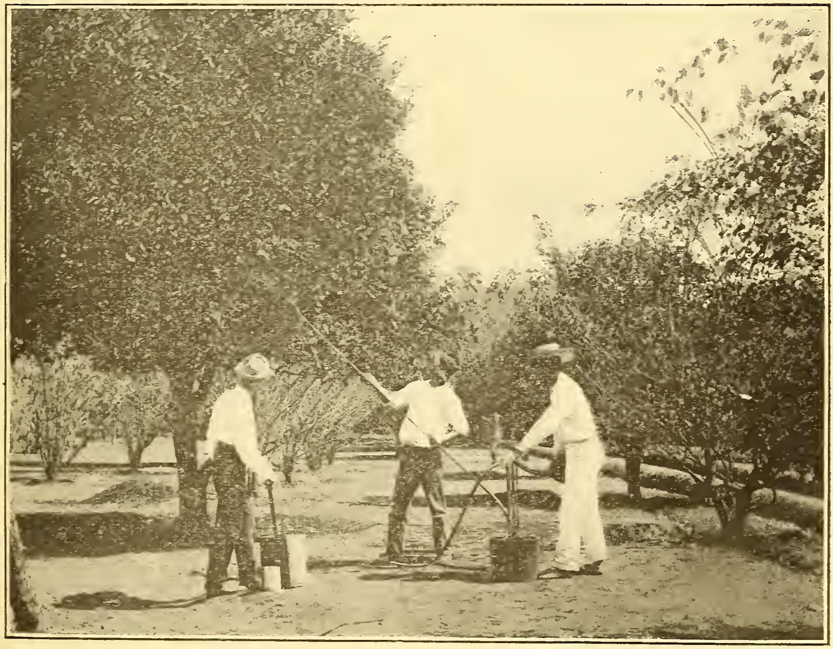

FIG. 2.—SPRAYING ORANGE TREES, HAWAII.

Cooperative experiments in cacao cultivation are being carried on in connection with the board of agriculture and the Hilo Boarding School. The station had on hand a large number of cacao seedlings, and an arrangement was effected by which the growing of this crop is to be investigated through a period running from seven to eight years.

In connection with these cooperative experiments investigations will be carried on upon the selection, propagation, and cultivation of bananas. During the past fiscal year arrangements were effected whereby several hundred banana plants were obtained through the Bureau of Plant Industry of the U. S. Department of Agriculture from Costa Rica, Central America, for planting in Hawaii. These were secured by the courtesy of the United Fruit Company, the only expense being that of transportation. The plants were received in Hawaii, fumigated, and turned over to the station for cultivation, the desire being to establish in the islands a type of banana which will bear shipping better than that now produced for the export trade. It is believed by many that the Bluefields or Central American bananas are superior in shipping and keeping qualities to the Hawaiian varieties, and it was only through the receipt of a large number of plants that this matter could be definitely settled in a comparatively short time.

INVESTIGATIONS.

The chemist of the station, who was appointed after the beginning of the present fiscal year, was compelled to work with very incomplete facilities until the finishing of the laboratory building. A room in the former office building was fitted up with shelving and tables and used for a laboratory. A gas machine was purchased, together with a limited amount of glassware and other apparatus, and the chemist has devoted a considerable portion of his time to research investigation, studying the composition of some of the organic compounds of the soil. In addition he has made analyses of a large number of samples of forage and fodder plants, a more extended report on which is given in the report of the chemist.

The horticulturist of the station, who submits elsewhere a report, was appointed in October, 1903, and has already issued a bulletin on bananas, which treats of the cultivation and marketing of bananas and brings together information regarding a large number of Hawaiian varieties, making possible a systematic study of this important food plant. Experiments are being continued on the cultivation and fertilization of bananas, and a large collection of varieties is being brought together on the station grounds. The horticulturist has also begun experiments in the propagation of mangoes and alligator pears, investigating the possibility of extending the propagation of the more desirable varieties by means of budding, grafting, etc. He also collected and prepared a large exhibit of fruits and horticultural products which was exhibited as a part of the Office of Experiment Stations exhibit in the Government Building at the Louisiana Purchase Exposition.

The entomologist has continued his investigation on the life history of numerous insect pests and prepared a bulletin on the cane leaf hopper, which treats of the life history of the pest, describes the injury produced, and offers suggestions for its control. In connection with this investigation the entomologist visited plantations on the various islands and also investigated a number of other insect enemies of field and garden crops, a report on which is submitted.

The special agent in charge of the station, in addition to attending to the business of the station as director and disbursing agent, has begun the investigation of some of the fungus diseases of coffee and other economic plants, and has made an attempt to bring together the coffee growers of the Hawaiian Islands into an association for their mutual advantage. Letters were addressed through the Department of State to the American consuls in Europe asking for samples and prices of the different grades of coffee, and with these reports as a basis it is believed that something can be done toward developing a market for the superior grades of Hawaiian coffee.

As previously reported, the special agent has begun a comparative test of grasses and forage plants, which is being carried on in cooperation with the Hawaii Live Stock Breeders' Association. Attempts have been made to import and distribute among the members of the association grass and forage-plant seeds from various parts of the world. Some of these seeds were not available through regular seed dealers, but through the efforts of the special agent it has been possible to secure rare seeds and to call the attention of the Stock Breeders' Association to numerous forage plants with which they were not familiar. The distribution of the seed has been made through the secretary of the association and the special agent in charge of the station, the seeds being sent to such localities as they were believed to be adapted to. Among the forage plants under special investigation are fenugreek, sand lucern, sulla, *Paspalum dilatatum*, Mitchell grass (*Astrebla pectinata*), Florida beggar weed, and white branching sorghum. In addition, arrangements have been made to secure seeds of white grama, red grama, side-oats grama, *Panicum bulbosum*, and a number of other species of grasses which are common on the dry land ranges in Southwestern United States. The station is taking up the analysis of fodder plants and grasses, both indigenous and exotic, with a view of obtaining information regarding their actual value.

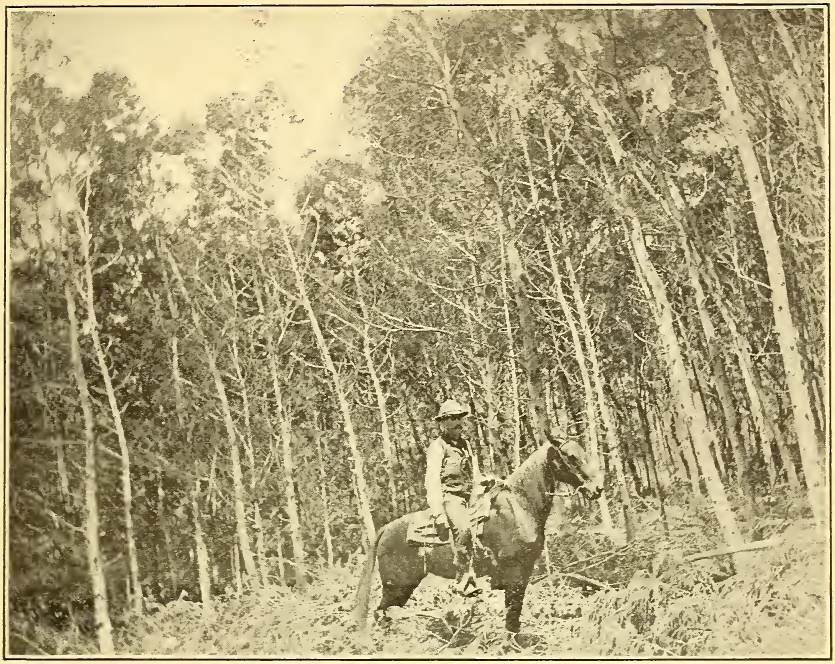

FIG. 1.—BLACK WATTLE PLANTATION, HAWAII.

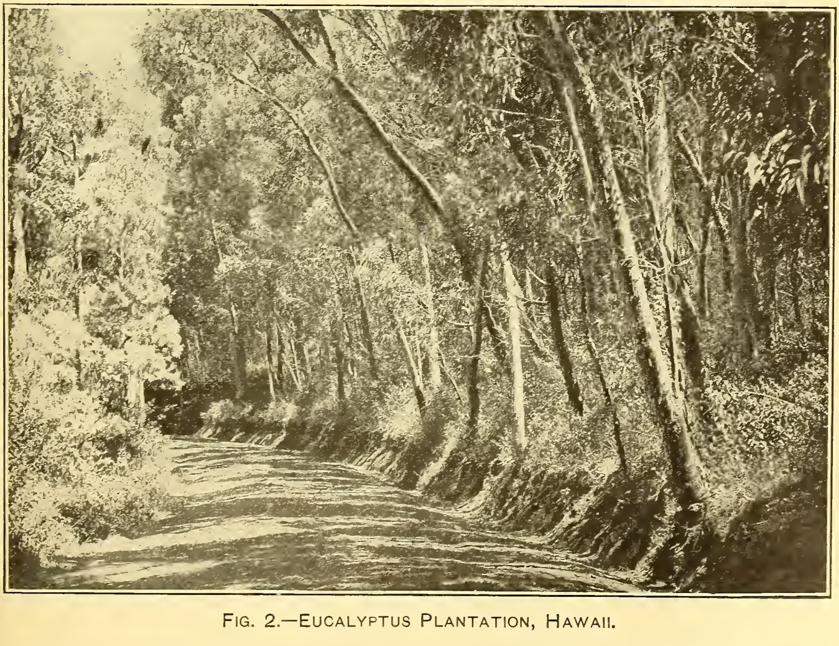

FIG. 2.—EUCALYPTUS PLANTATION, HAWAII.

There are on the station grounds some 5 acres of wattle trees (*Acacia mollissima*) which have been planted for from twelve to fifteen years (Pl. XV, fig. 1). The crop is mature and many of the trees are dying. The bark of these trees is of value for tanning purposes, and it is believed that at least 100 tons of tan bark, containing from 29 to 37 per cent of tannin, valued at from $25 to $35 per ton, can be secured from this plantation. In addition to the tan bark the timber would be available for cord wood, and the amount has been estimated at about 40 cords per acre. It is the intention to prepare and market this product, and if the venture proves a successful one and a market is established for this important tanning material, it is possible that a new industry may be developed, as the trees grow rapidly and produce abundantly. The cultivation of wattle trees has been followed in Natal and other parts of South Africa with success for a number of years, and it is believed that their cultivation can be made a commercial success in many parts of Hawaii. With the present interest in forestry and the necessity for planting denuded areas, it is possible that wattle planting could be followed instead of eucalyptus, which so far has had little value aside from the poles and firewood produced. (Pl. XV, fig. 2.)

FARMERS' INSTITUTES.

The farmers' institutes, which were organized through the efforts of the officers of the station in 1902, have been continued and have served of great value in bringing together individuals interested in agriculture and in securing the results of each other's practical experience. The appropriation of $300 made by the Territorial legislature was withdrawn by the special session of the legislature, and while this interfered with carrying out the plans to some extent, a number of meetings were held during the past year on the different islands. These were well attended and were largely devoted to the presentation of papers and discussion of topics related to diversified agriculture, and through them valuable data were secured relating to the interests of the small farmer. As an illustration of the range of topics discussed there were presented at the last meeting papers on cassava growing and starch preparation, citrus fruit production. banana growing and shipping, coffee raising, insect pests, etc. The special agent in charge of the station continues as president of the institutes, and Mr. J. E. Higgins is secretary of the organization.

PUBLICATIONS.

During the year three bulletins of the regular series and five press bulletins were issued.

Bulletin No. 5, A Sugar-cane Leaf Hopper, treats of the introduction of this pest and its distribution throughout the different islands.

Particular attention is paid to the life history of the insect, the entomologist having traced it through the various stages of its life.

Bulletin No. 6, Mosquitoes in Hawaii, was the result of investigations carried on in connection with the mosquito campaign to rid Honolulu of these pests. Notes are given on the distribution and abundance of mosquitoes in Hawaii, followed by a general account of their breeding places, life history, food habits, relation of mosquitoes to disease, and methods of control.

Bulletin No. 7, The Banana in Hawaii, treats of the cultivation of bananas, shipment, their diseases and insect enemies, as well as the various uses to which the banana, both fruit and plant, are put. Notes are given on the principal varieties of bananas in general cultivation, and descriptions are given of a large number of Hawaiian varieties.

Press Bulletin No. 6 is devoted to vanilla cultivation in Hawaii, in which the methods of cultivation, artificial pollination, and fermentation are described.

Press Bulletin No. 7, Mosquitoes, was issued in English, Hawaiian, Portuguese, Chinese, and Japanese. In this bulletin attention is called to the relation of mosquitoes to disease, and directions are given for their destruction, through the clearing up of their breeding places, etc.

Press Bulletin No. 8, The Mealy Bug or "Pear Plight" of the Alligator Pear, treats of what threatened to be a serious insect injury to the avocado or alligator pear growing, and offers practical suggestions for the destruction of the mealy bug.

Press Bulletin No. 9, Two Plant Diseases in Hawaii—Pineapple Disease of Sugar Cane and the Brown-eyed Disease of Coffee, calls attention to destructive diseases of sugar cane and of coffee and offers suggestions for their prevention.

Press Bulletin No. 10, The Pineapple Scale, describes a scale insect which is quite troublesome to pineapples, as well as other plants of economic importance. Various remedies are suggested for its control.

TOBACCO EXPERIMENTS IN HAMAKUA.

A preliminary report on the tobacco investigations is submitted herewith. In July, 1903, $2\frac{1}{2}$ acres of land were leased by the Secretary of Agriculture from Louisson Brothers, of Honokaa, for the purpose of carrying on tobacco experiments. The land chosen for this work is in the Pohakea tract, about 2 miles above the main government road through Hamakua, at an elevation of 1,600 feet. The land was selected by Mr. F. E. Conter, who visited the Kona, Hilo, and Hamakua districts in April and May, 1903, for the purpose of locating a suitable site for tobacco experiments.

The Hamakua soil is dark brown or black forest loam of very fine texture, light, porous, well drained, and, like all our island forest soils, rich in humus. The mechanical analysis indicates adaptability to the cultivation of the finer qualities of leaf.

Preliminary work was begun in August, 1903, the land plowed to the depth of 12 to 18 inches, the stones removed, and stumps and guava roots grubbed and burned. The field is on the edge of the forest, with a heavy growth of Ohia lehua (*Metrosideros polymorpha*) on three sides. The field was repeatedly harrowed and stirred to get the top soil in fine condition and keep down weeds. Seed beds were made, tools purchased, and a small shed built. Tenting cloth which had been ordered in May was not received at Honolulu until December. In the meantime a frame was constructed to cover 1 acre of ground, and all was in readiness to stretch the tent when the cloth reached Hamakua, in January, 1904. One set of seedlings was grown in the seed beds in anticipation of the early arrival of the tent cloth. These were cared for until too old for use, and, the cloth not having arrived, a new lot had to be started. The best seed having been used in starting the first crop of seedlings, no plants were available for transplanting until from the second crop, in March. The week of March 15 was spent in final cultivation and preparation of the soil. The tenting was stretched on the frame by March 29, and the whole field was planted by April 2. April, 1904, proved an exceptionally rainy month, with unusually low temperatures. There was a fall of 20.17 inches from April 8 to 13, with temperatures of 56° to 63° F. during that time. As a result the losses of transplanted tobacco were very high. On April 17 there was 9.50 inches of rain in twenty-four hours, and the total for April was 38 inches. Replanting had to be done continuously until June 1, so that a full stand was not secured until that date.

By the end of June a few of the plants were ripening their leaves, but too few were in satisfactory condition. Perhaps a hundred pounds of leaf might have been harvested at this time, but there was as yet no drying and curing house, the legislature having in the meantime retrenched its appropriation for this work, so that no funds were available. The diminished appropriation for the new fiscal year became available in July, 1904. A portion of this fund was immediately invested in a small and decidedly inadequate curing barn, new seed beds were built, and a new crop of tobacco from fresh seed sown in them. The leaf from the first crop and from the rattoon crop was harvested as it ripened, in July, August, and September, and cared for as best could be. The pick during these three months amounted to about 1,000 pounds of cured leaf, which was exceedingly variable in quality. The best has been bulked, and is now undergoing fermentation.

Deli, Florida Sumatra, and Java Sumatra comprised the largest portion of the crop. Sumatra tobacco, as has been noted by other experimenters, is quite variable as to habit of plant and form of leaf. Five to seven distinct types or strains are easily separable from the seedlings grown from any lot of imported seed. Some of these types are worthless. The best of them can undoubtedly be fixed by continued careful selection. Besides the Sumatra, a trial was made of Connecticut Broad Leaf, Vuelta Abajo, Connecticut Havana, Florida Havana, and Spanish Zimmer. The quality of the Cuban type tobacco has been uniformly much better than that of the Sumatra.

All of the first crop is now out of the way and a second crop has been planted, from which much better results are to be expected. Some of the experts to whom the raw, cured but unfermented, tobacco has been referred have reported very favorably upon it. Others have stated that it is badly cured and lacking in body; but, from the fact that there has been a wide range of opinion, there is room to hope that results may be better with better facilities for caring for the next crop. There are some points in its favor. The Pohakea tobacco colors well and shows a tendency to run to the dark shades—a good characteristic in both wrapper and filler leaf. The flavor, in so far as it can be determined from the unfermented product, is mild, not rank. The most promising factor is that the burn is good. A cigar rolled from our raw Cuban leaf burns evenly and without char, holds fire, and leaves a white ash.

From the beginning of the experiment careful notes have been taken in regard to every phase of the growth of the crop.

The experiment has hardly been a fair one, because of the numerous delays and the drawbacks attendant upon attempting to grow any new crop on new land in an untried locality. Mr. C. R. Blacow, who has had charge of the work since July, 1904, has the experiment well in hand, so that far better results may confidently be expected as a result of the second season's work. Mr. Blacow is preparing a detailed report on the results thus far accomplished.

I consider the outlook for tobacco cultivation in Hawaii good, provided land suitable for the crop can be placed at the disposal of those who have sufficient capital to engage in this industry. Not every soil is suited for tobacco; and, furthermore, large capital is required for the production and marketing of a high-class article, because of the time required to cure tobacco and get it into marketable shape. Men with limited resources can not afford to wait two or three years until the crop is fermented in bulk and warehouse. But if we can grow fine quality tobacco of either wrapper or filler types there is enough money in the business to tempt investors with large capital. The bulk of our sugar lands is not of the tobacco type. Not all of the coffee lands are suitable for tobacco, although the present experiment is being conducted in a coffee district. Compared with sugar and coffee, there is a far smaller area that could be profitably planted in this crop. Two hundred and fifty thousand acres produces all of the "good" tobacco grown in Cuba. We have perhaps one-tenth of that area on the islands of this group, mainly on Hawaii and Maui, that possesses the physical texture that is a prerequisite to tobacco cultivation.

The question as to whether or not we will be able to grow good tobacco in Hawaii is one which can not be quickly settled. It will require a number of years to demonstrate the matter one way or another. But this demonstration work should be carried on before we ask men to come here and invest their capital in this industry.

REPORT OF THE CHEMIST.

The appointment of the chemist, Dr. Edmund C. Shorey, dates from September 15, 1903. This station having at that time no laboratory, the chemist's time for the first few months was chiefly occupied in examination and arrangement of the chemical literature in the library and in the preparation of a list of books and periodicals necessary for this important part of a chemist's equipment. The works so selected have been added to this branch of the library, as the means available would permit, there being now 400 bound volumes and a large number of unbound journals and separates; and although small, it is the only collection worthy the name of a chemical library in the Territory.

Through the courtesy of the Territorial board of health the chemist was allowed the use of the laboratory of the food commissioner, and in this laboratory partial analyses of several samples of soil were made during October and November, 1903. During these months there was also made a thorough examination of the soil conditions in two sections on this island (Oahu) and soil samples were collected for future work. The sections covered were the Wahiawa colony and adjacent lands and the experiment station land and adjoining territory on Punchbowl and Tantalus.

In February, 1904, it being evident that the construction of the new laboratory would be unavoidably delayed, a temporary laboratory was fitted up in one room of the building occupied as office and library. The work done in this laboratory was necessarily confined to such as could be done in small space with very simple apparatus. This included determinations of nitrogen in quite a large number of soils; the beginning of a research on the nature of the nitrogen compounds in Hawaiian soils rich in nitrogen, and, as closely bearing on this research, a study of nitrification, denitrification, and soil acidity. With the exception of the nitrogen determinations noted above, this work was confined to one soil. In regard to the nature of the nitrogenous compounds in Hawaiian soils, although the work is but just begun, results have been obtained which are considered important in that they throw some light on the composition of that little-known body or collection of bodies called "humus."

Beginning February 1 the rainfall at the lower end of the station was collected and analyzed, the chlorin, nitrate, and ammonia contents being determined.

Miscellaneous samples were examined and reported on as follows: Five samples of silk fabrics for the customs department; samples of sugar and taro for the Quartermaster's Department, United States Army; samples of flowers of sulphur, and "molascuit" for private parties.

During the last months of the year a beginning was made in the collection, drying, and grinding of samples of Hawaiian-grown fodders, preparatory to analysis of the same.

A list of apparatus necessary for the equipment of the new laboratory has been prepared, and it is expected that this laboratory will be completed and in working order in October, 1904.

Work planned for the year ending June 30, 1905, may be briefly stated as follows:

(1) Continuation of the research on the nature of the nitrogenous compounds in Hawaiian soils.

(2) Analyses of Hawaiian-grown fodders.

(3) Examination of soils and advice regarding the fertilization or cultivation of the same when request is made.

In recognition of the fact that research should be prominent in experiment-station work, the research on the nitrogen compounds in Hawaiian soils will have first place. In Hawaii the soil of a large area of upland open, or likely to be open, for settlement is high in nitrogen and humus, the nitrogen averaging 1 per cent or more and the humus 8 to 14 per cent. Little or nothing is known of the nature of the nitrogen compounds in these soils, or, in fact, in any soils, and our knowledge of humus may be summed up in the statement often made, "It's constitution is not well understood." Now, no matter what the fertility of a soil may ultimately be found to depend upon, there is no question that a knowledge of the constitution of soil ingredients is an important step in the solution of the problem. One per cent of nitrogen, when calculated to nitrate of soda, is equivalent to more than 100 tons per acre to the depth of 1 foot; but in spite of the vast store of nitrogen present in nearly all our soils, the planters of Hawaii spent $1,020,300 for nitrogenous fertilizers in producing the sugar crop of 1903. It is evident that any light thrown on the question how to make more readily available this large store of nitrogen will have an immediate monetary value. The only scientific method of approaching this problem is to ask, What is it which we wish to make available? or, in other words, investigate the constitution of the nitrogenous compounds present in the soil.

A great many requests have come to this station for information regarding the composition of fodders. Up to the present these inquiries have been answered, when possible, by giving published analyses of fodders grown elsewhere. The question whether such fodders as sorghum and alfalfa have the same composition when grown here as elsewhere having come up, and there being in common use quite a number of which no analyses are available, a series of analyses of Hawaiian-grown fodders will be made. These analyses will be made according to the regular scheme for feeding stuffs, with probably determinations of the most important ash ingredients. Such analyses, when published with the proper explanation of their value, will be appreciated by dairymen and ranchers here.

There have been during the year quite a number of requests for analysis of soils and advice regarding fertilizers based on analysis, and with the completion of the new laboratory these requests will probably multiply. There is probably no more unsatisfactory task which can beset an analytical chemist than to give advice regarding the treatment of a soil based on chemical analysis only. This is true of soils anywhere, and the conditions which make it so are accentuated here. Analyses of Hawaiian soils have been made in large number. Experiment station, plantation, fertilizer, and private chemists have been working on them for years, and advice good, bad, and indifferent has been given. In consequence there are a large number of people here who consider chemical analyses of soils of no value whatever, and a perhaps equally large number who have implicit confidence in soil analysis to solve all the problems incident to the growing of crops. This latter class is the more difficult for the soil chemist to deal with, for if he refuses to give advice based on the examination of a handful of soil taken he knows not where or how, and about which he knows absolutely nothing except what is disclosed by the analysis, he is at once classed by them as incompetent.

Again, the official and other methods of analysis commonly used are in many respects not suited to Hawaiian soils. Furthermore, it is recognized that the best results, or in fact the only results from chemical analysis of soils, can be obtained where these have been extended, and are viewed in relation to crop returns, the results of fertilizer tests, climatic conditions, and, in fact, all the factors which enter into crop production. The experiment station of the Hawaiian Sugar Planters is in a position to make this use of soil analysis, but this station has no Hawaiian soil data, and can obtain for present use only that which is most fragmentary and disconnected. Moreover, scientific data of any kind are wholly wanting in regard to the growing of many tropical crops, and the study of the chemical or any other phase of the growing of such crops will have to be de novo.

In meeting requests for soil analyses and advice in cultivation or fertilization based on such analyses, the policy of this station will be first to teach what chemical analysis of soils means, its application and limitation, and to give advice only when all the data bearing on the question are available.

ENTOMOLOGICAL WORK (D. L. VAN DINE).

The two-roomed building, formerly the office of the station, is now occupied by the entomologist as office, library, and laboratory. Adjoining this building there has been erected during the year a glass-covered structure for use as an insectary. Additional office furniture and laboratory apparatus are needed, some of which have already been ordered, and the balance will be obtained as the means of the station will allow. The entomologist is in need of an assistant, but such an appointment is not possible in respect to more pressing needs of the station. The present range of the investigations of this department could be greatly broadened by such an appointment. More accurate and detailed information could be obtained from the breeding experiments, since an interruption renders previous work incomplete and necessitates repetition. Furthermore, the routine work of the office and laboratory prevents a personal investigation of many problems which can be satisfactorily solved only by careful observations in the field. No great length of time can be spent on any one phase of the work without seriously neglecting other duties.

CORRESPONDENCE.

The correspondence of this Department has nearly doubled during this second year of work. This can roughly be classed under two heads, (1) communication with the workers on the mainland and in foreign countries, and (2) replies to local inquiries regarding injurious insects. The entomologist is indebted to many workers in the United States and abroad for literature regarding certain pests in particular and for the receipt of available entomological publications in general, and would especially acknowledge the continued help given by Dr. L. O. Howard, Chief of the Bureau of Entomology of this Department and his assistants, in determinations made during the year and references to literature regarding certain species.

PUBLICATIONS.

The entomological publications for the past year consist of a revised edition of Bulletin No. 3 of the regular series; Press Bulletin No. 7, giving brief directions for ridding door-yards and houses of the breeding places of mosquitoes, printed in English, Portuguese, Hawaiian, Chinese, and Japanese on cardboard to be posted in conspicuous places; and Press Bulletin No. 8, a popular discussion of a mealy bug, *Dactylopius nipæ*, a destructive pest of the alligator or avocado pear, with directions for combating the same.

Two bulletins of the regular series have been prepared for publication during the fiscal year 1905. These deal with subjects that have received special attention and study during the year. One, Bulletin No. 5, entitled "A Sugar-cane Leaf Hopper in Hawaii," is a summing up of investigations begun the previous year on an hemipterous insect belonging to the family Fulgoridæ. This is a recently described leaf hopper (*Perkinsiella saccharicida*), which has invaded the cane fields throughout the islands to a serious extent. The bulletin deals with the introduction of the pest; its life history and habits; the injury to the cane; the symptoms of its work; the limitations of the work of natural enemies in controlling the pest; the natural enemies to be found in the cane fields, and remedies—the control of the pest by active measures and cultural preventive methods. The other bulletin, No. 6, entitled "Mosquitoes in Hawaii," is a discussion of the mosquito problem. It contains information on the introduction of mosquitoes into Hawaii; their distribution and abundance; a general account of the present knowledge of mosquitoes regarding their breeding places, life history, migrations, food, and relation to disease; the common Hawaiian mosquitoes; their natural enemies, and methods of control. A press bulletin on the pineapple scale (*Diaspis bromeliæ*) is completed and will be published as Press Bulletin No. 10. A general detailed report on some fifty species of injurious insects of Hawaii is also in the course of preparation and will be published in bulletin form. Aside from the applied work there is in preparation a technical paper containing the results of a comparative anatomical study of the adult mouth parts of certain families of Hymenoptera.

The entomologist has been active during the year in farmers' institute work and has continued to aid, in an advisory capacity, the citizens' campaign to rid Honolulu and vicinity of mosquitoes.

A PARTIAL LIST OF THE INJURIOUS INSECTS OF HAWAII.

The most practical arrangement of the injurious insects is in accordance with their hosts or food, irrespective of their scientific classification. A general report concerning the principal injurious insects of Hawaii will be published in bulletin form, following this plan. Later, it is hoped, each group can be carefully worked out more in detail and presented separately. The following list embodies the above idea:

SUGAR CANE.

The sugar-cane leaf hopper (*Perkinsiella saccharicida*) is a Fulgorid recently introduced from Queensland or China. The loss on last year's crop is estimated to be not less than $3,000,000, the gross value of the entire crop being about $30,000,000. Greatest injury was wrought on the unirrigated plantations situated in the windward districts; epidemic during the winter season, when growth practically ceases; confines its work to cane.

The sugar-cane borer, the larva of *Sphenophorus obscurus* is generally distributed. Until the recent invasion of the leaf hopper this beetle was the most serious pest of cane in the islands; introduced from Tahiti; observed as early as 1865 in the vicinity of Lahaina, island of Maui; determined by the Division of Entomology, U. S. Department of Agriculture, in 1885 from specimens forwarded by King Kalakaua; damage to cane estimated to be $500.000 per annum; not abundant in the dry districts; overirrigation or abundant rainfall favors the development of the pest; may be controlled by burning off and picking; infests also the banana (*Musa* spp.), wine palm (*Caryota urens*), royal palm (*Oreodoxa regia*), the cocoanut palm, and the papaya (*Carica papaya*).

The sugar-cane leaf roller, the larva of *Orneodes accepta*. The larva of this moth of the family Pyraustidæ was recently described for the first time by Doctor Dyar, of the U. S. National Museum, from specimens collected by the entomologist of this station; became serious on limited areas on the mauka loa (extreme mountainward) fields of certain plantations on the island of Hawaii; taken also from Hilo grass (*Paspalum conjugatum*) growing wild above the cane, from which it undoubtedly invaded the cane fields.

A mole cricket (*Gryllotalpa africana*) was reported during the year as injurious to young cane from two plantations on the island of Oahu.

The sugar-cane mealy bug (*Dactylopius calceolariæ*) was found in abundance beneath the lower leaf sheaths in some fields on two of the eleven plantations visited during the year.

Cypress girdler (*Eleutheroda dytiscoides*) was found in large numbers beneath the trash of cane in the Kohala district, island of Hawaii, doing no apparent damage except to basal joints of the lower leaf sheaths; taken also from Monterey cypress in the gulches, doing serious damage by girdling the bark of small limbs and branches; reported also from Kona, same island, as injurious in the same manner to lime trees.

The Maui or Olinda bug (*Aramigus fulleri*) is a well-known beetle on the mainland; common horticultural pest on the islands of Maui and Hawaii; recently injurious to field crops, damaging corn on the island of Maui and Irish potatoes and sugar cane on the island of Hawaii; taken also from "oe" (Verbenaceæ) and guava bordering the cane field, from which plants it undoubtedly invaded the fields.

COFFEE.

The "coffee blight" (*Pulvinaria psidii*). This scale insect has done serious damage to coffee in some districts; found the past year in abundance on neglected trees in the vicinity of Hilo, island of Hawaii; infests also the guava and certain ferns.

The torpedo bug (*Siphanta acuta*). This leaf hopper occurred in large numbers on coffee in the Hamakua district, island of Hawaii; undoubtedly plays an important part in the dissemination of the brown-eyed disease (*Cercospora coffeicola*) of coffee; taken also from mango, orange, and lime.

The "black fly" of coffee (Aphididæ). Undetermined; abundant on the new growth in the Hamakua district.

CITRUS TREES.

The following scale insects, with the exception of the latter, are common and abundant on citrus trees.

The purple scale (*Mytilaspis citricola*) and a tropical species of the same genus (*M. pinnæformis*).

The California red scale (*Aspidiotus aurantii*).

The fluted scale (*Icerya purchasi*) was taken the last year from the black wattle (*Acacia decurrens*) and found in abundance on the ironwood (Casuarina); it was received also on twigs of the lime from Kaupo, Maui, where it was reported to be doing serious damage.

OTHER CITRUS PESTS.

The orange aphis (Aphididæ). Undetermined; very common and abundant on new growth.

The torpedo bug (*Siphanta acuta*). Noted under "Coffee."

ALLIGATOR OR AVOCADO PEAR.

The pear blight (*Dactylopius nipæ*). This mealy bug is generally distributed and abundant; besides the alligator pear, it infests the fig, guava, grape, and breadfruit.

A scale insect (*Fiorinia fioriniæ*) was found on the under side of the leaves of neglected trees.

PINEAPPLE.

The pineapple scale (*Diaspis bromeliæ*) and the pineapple mealy bug (*Dactylopius* sp.) are both to be found wherever pineapples are being grown throughout the islands and occur in serious numbers on some plantations.

MANGO.

The torpedo bug (*Siphanta acuta*). Noted under "Coffee;" accompanied by a "smut," a fungus similar to that following the attacks of certain plant lice (Aphididæ), and followed by a destructive fungus determined at the Bureau of Plant Industry as *Colletotrichum* sp.

BANANA.

The cane borer, the larva of *Sphenophorus obscurus*. Noted under "Sugar cane."

The banana borer (*Calandra remota*) is common; recorded by Blackburn as infesting "especially stems of cactus and banana," Oahu, 1885. This beetle belongs to the same family as the cane borer Calandridæ.

The banana leaf roller, the larva of *Orneodes blackburni*. The larva of this moth is at times very destructive to the leaves of the banana; infests also the cocoanut palm, and because of its work on this plant is known in some localities as the "cocoanut leaf worm." The cocoanut trees about Honolulu are seriously disfigured by this pest.

GARDEN PRODUCTS.

The melon fly (*Dacus cucurbitæ*) is a true fly of the family Trypetidæ. The larva infests the fruit of all plants of the family Cucurbitaceæ; destructive also to beans and tomatoes.

Cutworms, the larvæ of *Agrotis* sp. Several species; common and general feeders on garden products; work observed on corn, cabbage, and potatoes.

The cabbage butterfly (*Pieris rapæ*) is very common and destructive.

The cabbage aphis (undetermined) is abundant.

The corn leaf hopper (*Dicranotropis maidis*) belongs to the same family as the sugar-cane leaf hopper; similar to that species, but smaller in size; found on corn and grasses and reported as formerly injurious to cane.

The "green fly" of corn (*Aphis* sp.) injured seriously the corn in the Kula district, island of Maui, the previous season.

The black ground beetle (*Ompatrum serratum*) is a common Tenebrionid which did much damage to ripe strawberries at the station the last season.

OTHER HORTICULTURAL PLANTS.

The Japanese beetle (*Adoretus umbrosus*) is a general feeder on trees and shrubs, especially destructive to roses and grapes.

The Maui or Olinda bug (*Aramigus fulleri*) is the well-known Fuller's rose beetle of the United States. It is very common in certain districts on the islands of Maui and Hawaii. Where this pest abounds it is equally if not more injurious than the Japanese beetle; previously considered entirely an horticultural pest, but recently attacking the crops of the field. Noted under "Sugar cane."

The peach scale (*Diaspis amygdali*) was found on peaches at Makaweli, Kauai.

The rose scale (*Diaspis rosæ*) is common on roses throughout the islands; reported as infesting the mango.

TOBACCO.

The tobacco cutworm, the larva of *Agrotis ypsilon*. This species is one of the abundant cutworms noted under "Garden products," especially destructive in seed beds and to young plants in the field; observed at the experimental field of this station, in Hamakua, island of Hawaii.

The tobacco budworm, the larva of *Heliothis obscura*. Known also as the cotton bollworm; as yet not serious, since neither cotton nor tobacco is a common crop.

The tobacco leaf miner, the larva of *Phthorimæa operculella*. Bred from the larvæ infesting the stems of tobacco; taken at the experimental field Hamakua, Hawaii.

The tobacco flea-beetle, *Epitrix parvula*. Common; reported as infesting also the eggplant and poha (*Physalis peruviana*).

HOUSEHOLD INSECTS.

Mosquitoes (Culicidæ). The three common species are the "night" mosquito (*Culex pipiens*) and the "day" mosquitoes (*Stegomyia fasciata* and *S. scutellaris*). The former species is the abundant mosquito; throughout the Territory it is necessary to screen the houses, or if that can not be afforded, use nets over beds at night and burn buhach powder. During the past year much has been done to lessen the numbers of these pests by the proper treatment of their breeding places.

Cockroaches (Blattidæ). Probably the most disagreeable pests to the housewives are the cockroaches. The three house-frequenting species are: *Periplaneta americana*, *Periplaneta australasia*, and *Ectobia germanica*. The two former species are the common large cockroaches; they infest all sorts of foods stuffs, and cause much damage to starched clothing, books and papers in libraries, and wall paper.

The house fly (*Musca domestica*) is common and periodically abundant in certain localities, but not generally so.

Ants (Formicidæ). Several species; undetermined; as is common in the Tropics, they are very numerous and the cause of much annoyance to housekeepers.

The silver-fish (*Lepisma* sp). Order Thysanura; destructive to books and papers in libraries, food stuffs, and silks and woolens in dry goods stores.

The white ant (*Calotermes marginipennis*). Family Termitidæ; very destructive to timbers in buildings and furniture; another species of the same genus was observed working in live Ohia (*Eugenia malaccensis*) in the Kohala forest.

The carpenter bee (*Xylocopa aeneipennis*) is very destructive to timbers in houses, telephone poles, and fence posts; works for the most part in redwood.

The mud dauber (*Pelopæus* sp). This wasp is a nuisance in houses on account of its habit of building a nest of mud about the ceilings of lanais and rooms.

Clothes moths and a carpet beetle are common and complete the list of household insect pests. Larvæ have been collected and adults will be bred for determination.

STORED PRODUCTS.

The rice weevil (*Calandra oryza*) was received during the year from Makawao, Maui, infesting stored corn; taken also from tobacco and various food stuffs.

The cigarette beetle (*Lasioderma serricorne*) is a serious pest to stored tobacco and cigars; bred from cigars, red pepper, and "Paprica;" recently received in large numbers by a local firm in a shipment of tobacco.

The bamboo beetle (*Dinoderus minutus*) infests bamboo furniture and baskets; known locally by the Japanese furniture dealers as the "bamboo worm."

The rust-red flour beetle (*Tribolium ferrugineum*) was bred from cracked rice and from a patented stock food.

The bean weevil (*Bruchus obtectus*) was received from Naalehu, Kaui; from stored beans.

LIVE STOCK.

The horn fly (*Hæmatobia serrata*) is a serious pest on cattle ranges; the extensive area and semiwildness of the stock prevent active measures of control; this pest, together with lack of food and water, often causes death to the animals.

The "night" mosquito (*Culex pipiens*). Noted under "Household insects;" a common disease of young fowls (*Epithelioma contagiosum*) locally known as "sore-head" is due to a parasitic fungus. One source of infection of this disease is undoubtedly through the wounds caused by the bites of this mosquito, the young chicks being unprotected by a growth of feathers.

HORTICULTURAL INVESTIGATIONS.

The appointment of the horticulturist, Mr. J. E. Higgins, dates from October 3, 1903.

During the first month the work of preparing the exhibit of agricultural products for the St. Louis Exposition was completed. This consisted in packing, labeling, and indexing specimens of the varied agricultural products of the islands. The fruit and other perishable articles were shipped with no other packing than the preserving liquid in which they were immersed. They are reported to have arrived at St. Louis in good condition.

BANANAS.

A considerable portion of the work of the past eight months has been with bananas. This has been twofold in its nature; a search was made into the literature of the subject, which is quite scattered and fragmentary, and observations and investigations have been made in connection with bananas growing in these islands. The subject has been considered not only from the immediate commercial standpoint, but an attempt has been made to become more familiar with the numerous so-called "native" bananas and to make descriptions of them. This has been a work involving great difficulty. These varieties are scattered throughout the island group, and some of them are becoming exceedingly rare or almost extinct because of the ravages of cattle in the forests and the decadence of an agricultural class among the native Hawaiians. It is generally only the most aged who know anything of these relics of ancient cultivation. The difficulty is further increased by the frequent use of local names for these varieties, thus giving rise to many synonyms. Some of the native forms may prove of considerable commercial value in the future. A collection of over thirty "native" and introduced forms is now in the experimental plats and is being added to as opportunity offers. A bulletin containing the results of these researches has been prepared and is now ready for publication.

An importation of Bluefields banana plants (Jamaica or Martinique variety), which was received by the Territorial board of agriculture and forestry, has been cared for at this station. They are being propagated for distribution later and are at present making a very satisfactory growth.

THE MANGO.

The mango has received frequent attention throughout the year. Some thirty or forty varieties of the fruit have been collected and studied with more or less care. A few of these may prove to be of commercial value and many more are useful for home consumption.

The grafting of the mango, when the art has become more generally learned, will doubtless make some of the superior varieties more common than they are at present, and will do much to establish a mango industry. This fruit is destined to take a prominent place in the great American markets. Successful experiments in budding the mango have been conducted by the horticulturist, showing that it is perfectly practicable to propagate it by this method in these islands.

A serious disease of the mango was found to be very prevalent in many parts of the islands, which has destroyed a large part of the season's crop. It attacks the flowers and the new leaves, causing them to turn black and die, and also disfigures the fruit. This was first studied at Hilo, where the horticulturist was engaged in field work in connection with bananas. From the very imperfect observations which it was possible to make under these conditions, it was concluded that the disease was probably due to a fungus attack. Specimens of the diseased parts were later forwarded to Dr. A. F. Woods, vegetable physiologist and pathologist of the U. S. Department of Agriculture, who reports that "the fungus, a Colletotrichum, is in fine fruiting stage in the cracked areas in the fruit and in the minute blisters on the twigs, but is less fully developed on the leaves." Through the kindness of Doctor Woods, the matter is being further investigated. During the following season experiments will be conducted in attempting to control the attack by means of fungicides.

CABBAGE ROT.

A field of cabbage which had been planted as a test of certain varieties was attacked by the black rot, a disease caused by the bacterium *Pseudomonas campestris*. The attack was very severe and afforded the opportunity to study the resistant qualities of different varieties. The results of these observations may be published later.

During almost the entire period while these plants were growing the weather was unusually wet. When the crop was removed the field was immediately prepared for replanting with cabbage plants, the object being to observe the effect of dry weather, since the wet season was then about at an end. Although the disease again appeared it was much less serious than during the rainy weather.

CACAO EXPERIMENTS.

During the last half of the fiscal year arrangements have been made for conducting experiments in growing cacao. The climate of the Hilo district being better adapted to this culture than that to be found where the station lands are located, the experiments will be carried on there in connection with the agricultural work of the Hilo Boarding School and under the immediate supervision of this station. The work will begin at once.

AVOCADO PEARS.

During the past season thousands of avocado pears have been wasted or fed to stock. This has been the case for several years. These fruits, if placed in the American markets, would sell for large prices. That it is perfectly possible to place them at least in Pacific coast markets is beyond question. They have frequently been sent to San Francisco, and even greater distances, arriving in good condition. A very successful shipment was made from this station to Manila last season. A considerable shipment of avocadoes was made through the U. S. Department of Agriculture to New York. Most of the fruit reached New York in good condition and sold well upon the market. This experiment was in the nature of a preliminary one to test methods of packing, relative value of varieties for shipment, etc., and if a more extended shipment should prove equally successful, this will open up a new field for the distribution of this fruit.

When the art of budding or grafting these trees shall have been perfected there will be nothing to prevent the avocado from becoming an important article of export from these islands. There are many forms here of excellent flavor and texture and very fine in appearance. The season of ripening, with the different varieties, covers nearly half the year.

TRAVELING.

During the month of January, 1904, a trip was made to Hilo and the Olaa district and return. This occupied about three weeks, the chief work being the study of bananas and advising those who had recently embarked in commercial banana growing. A similar tour was made of the west side of Hawaii in June, including several days spent at Pohakea in transferring the tobacco experiments from Mr. F. E. Conter, resigned, to Mr. C. R. Blacow. Other traveling of less importance has been performed from time to time as occasion demanded.